Dynamic tracer dispersion method: A tool for measuring the total methane emission from individual Danish landfills

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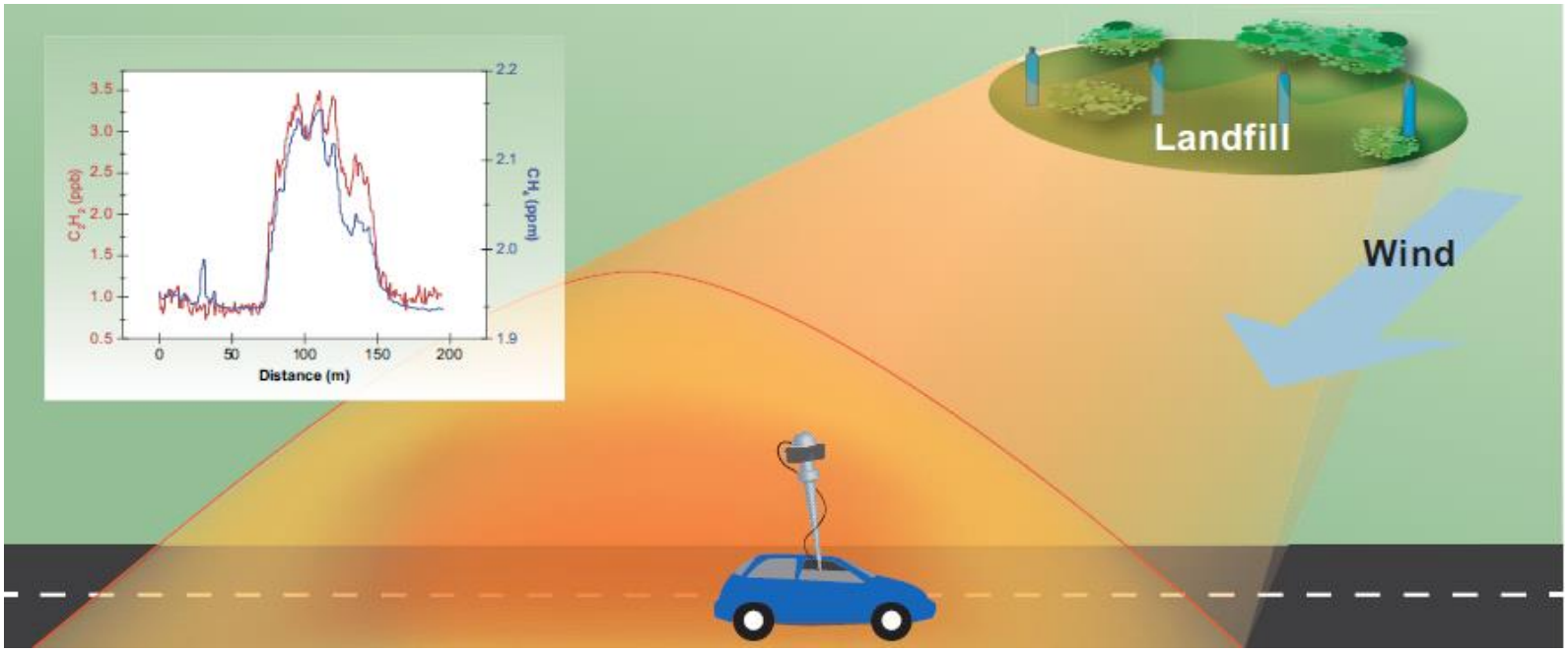
Dynamic tracer dispersion method

A tool for measuring the total methane emission from individual Danish landfills



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Karsten Fuglsang, FORCE Technology
Charlotte Scheutz, DTU DTU Environment

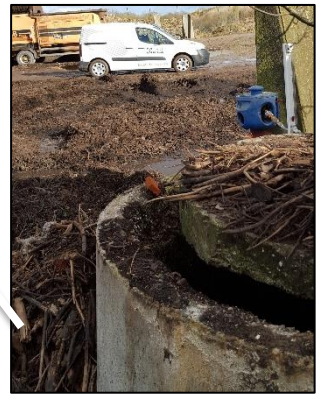
Dynamic tracer dispersion method

- Theory

$$E_{gas} = Q_{tracer} \cdot \frac{\int_{Plume\ end\ 1}^{Plume\ end\ 2} C_{gas}\, dx}{\int_{Plume\ end\ 1}^{Plume\ end\ 2} C_{tracer}\, dx} \cdot \frac{MW_{gas}}{MW_{tracer}}$$

- In practice

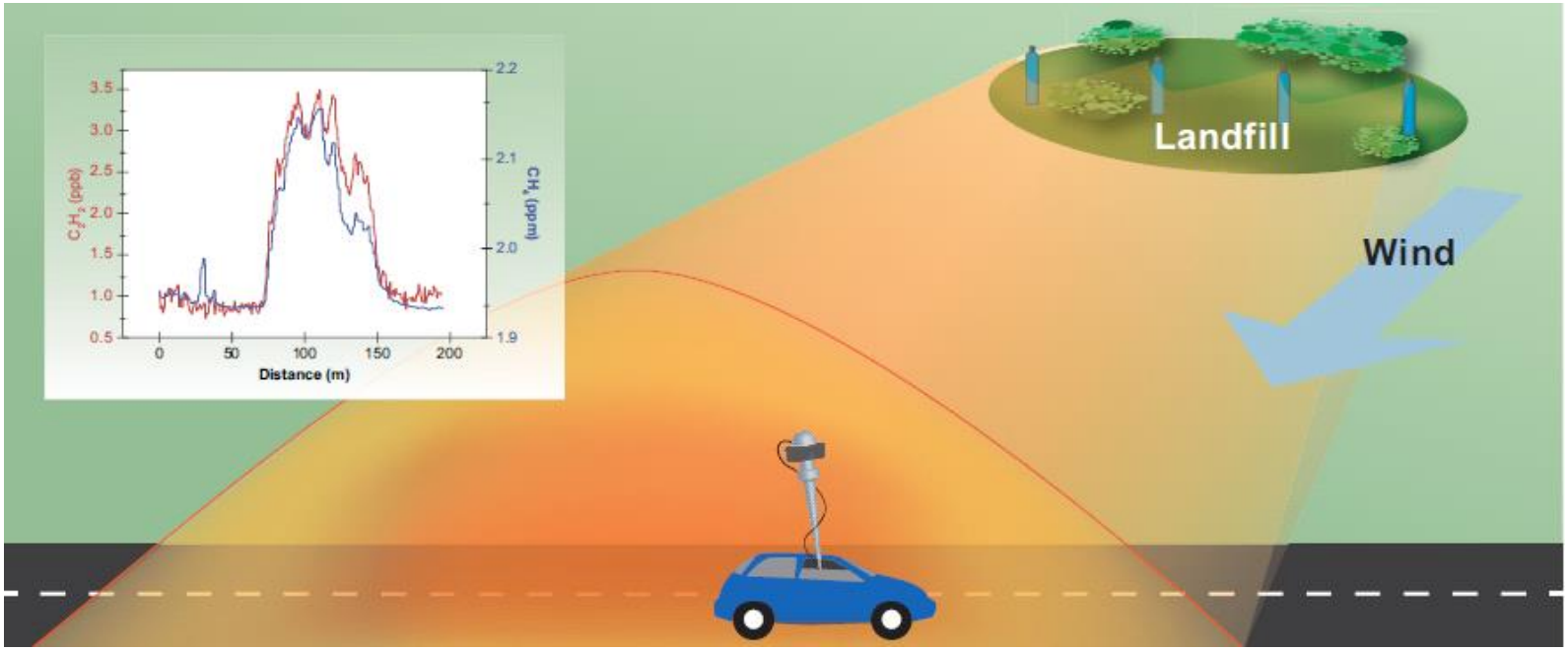
- Uncertainties



- Possibilities

- Results & Conclusion

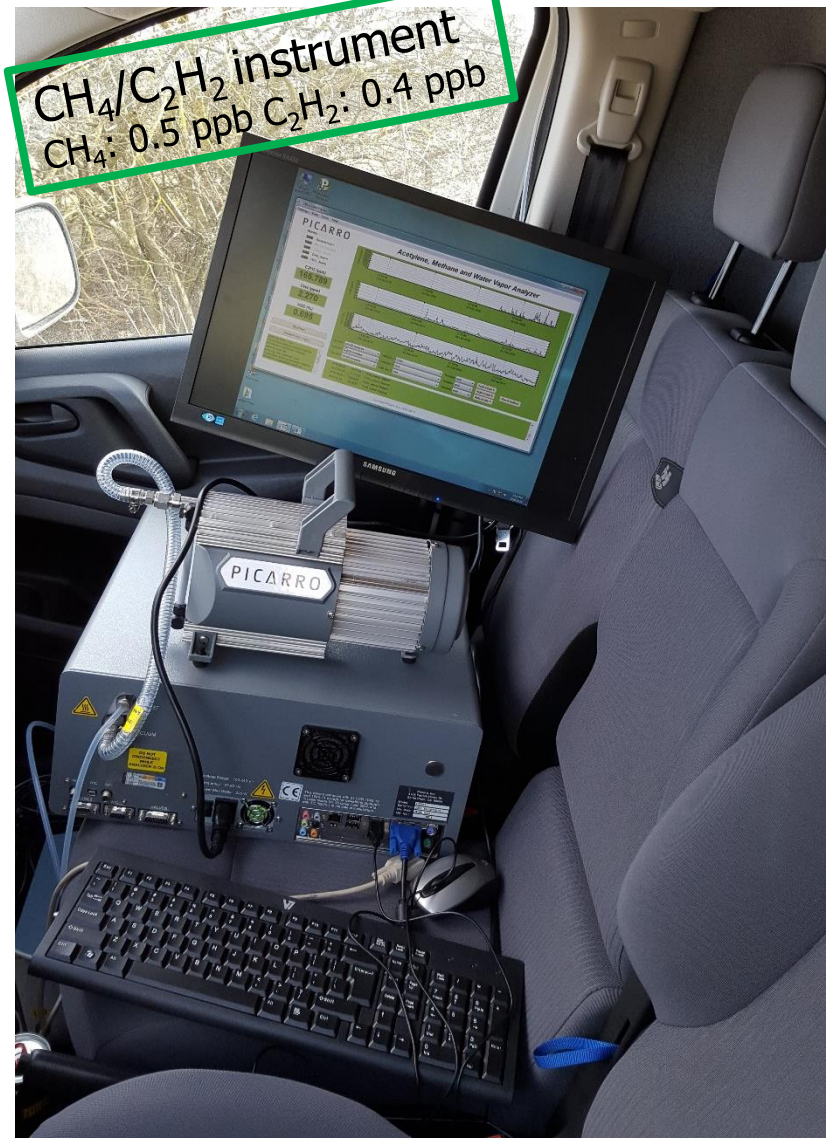
Dynamic tracer dispersion method Theory



$$E_{gas} = Q_{tracer} \cdot \frac{\int_{Plume\ end\ 1}^{Plume\ end\ 2} C_{gas}\, dx}{\int_{Plume\ end\ 1}^{Plume\ end\ 2} C_{tracer}\, dx} \cdot \frac{MW_{gas}}{MW_{tracer}}$$

- Tracer gas with long atmospheric lifetime
- Good/stable wind & road conditions
- Sensitive analytical instrument

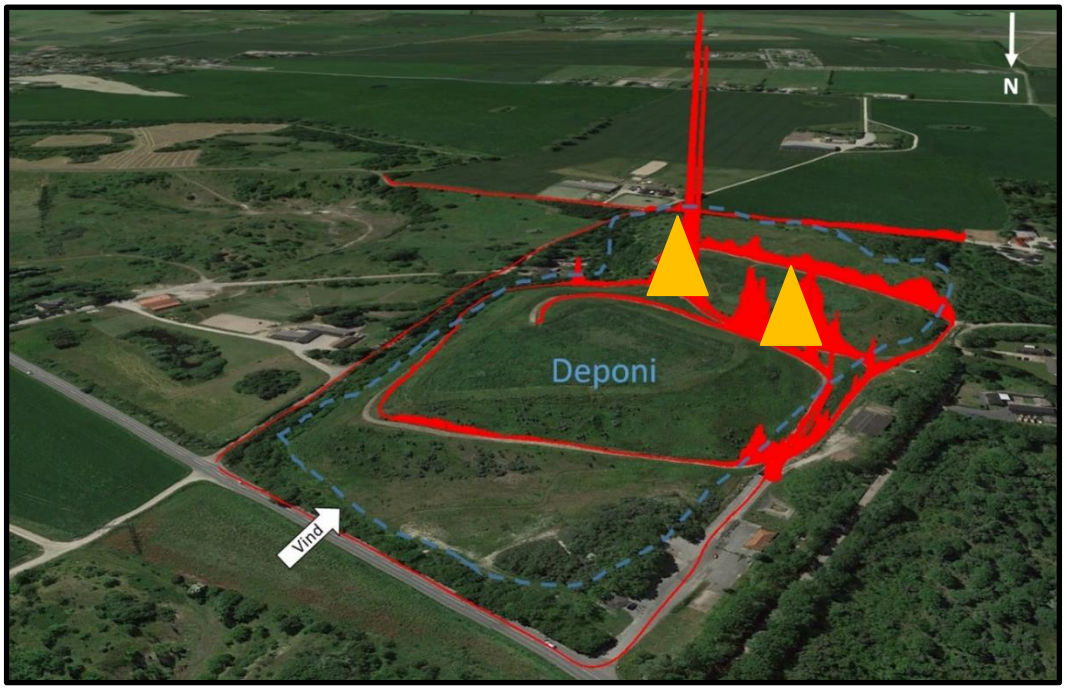
Dynamic tracer dispersion method
Practice



Tracer gas (C_2H_2)

Dynamic tracer dispersion method Practice

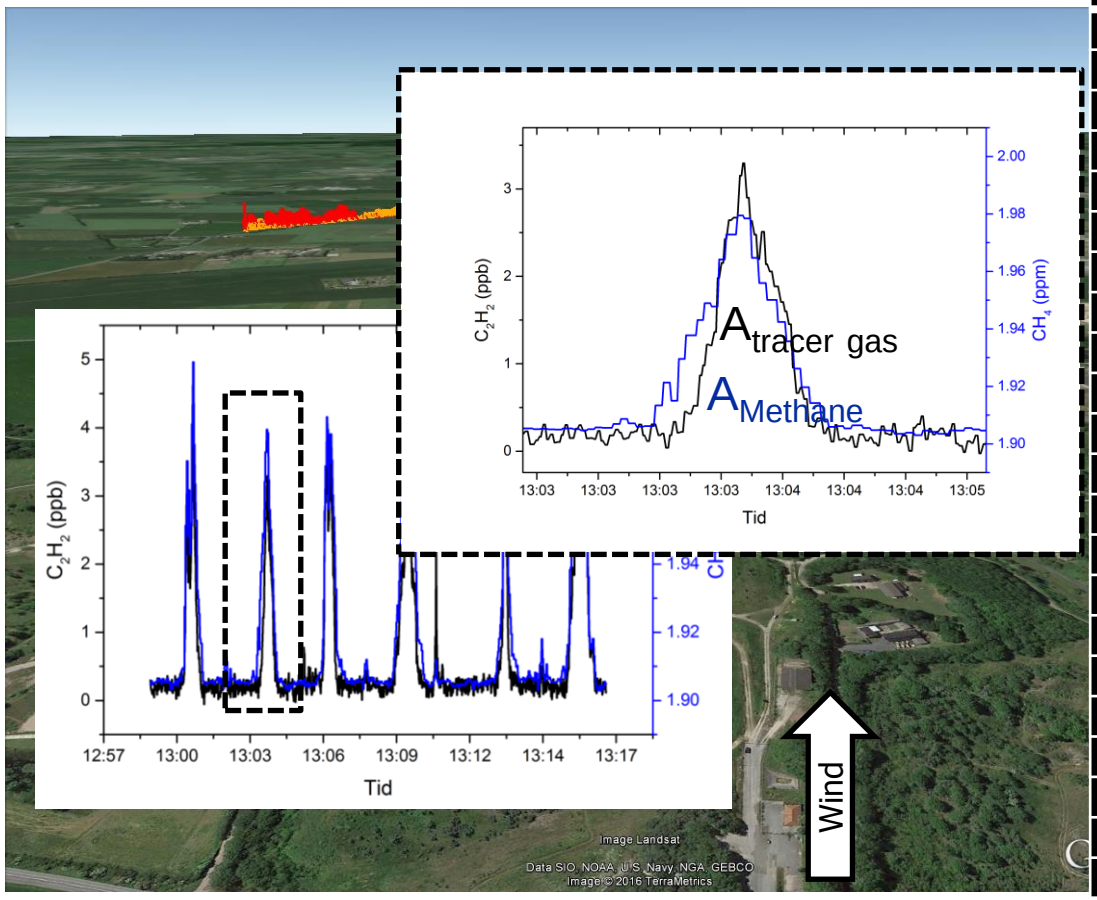
1) Screening for methan



2) Tracer gas placement

Dynamic tracer dispersion method Practice

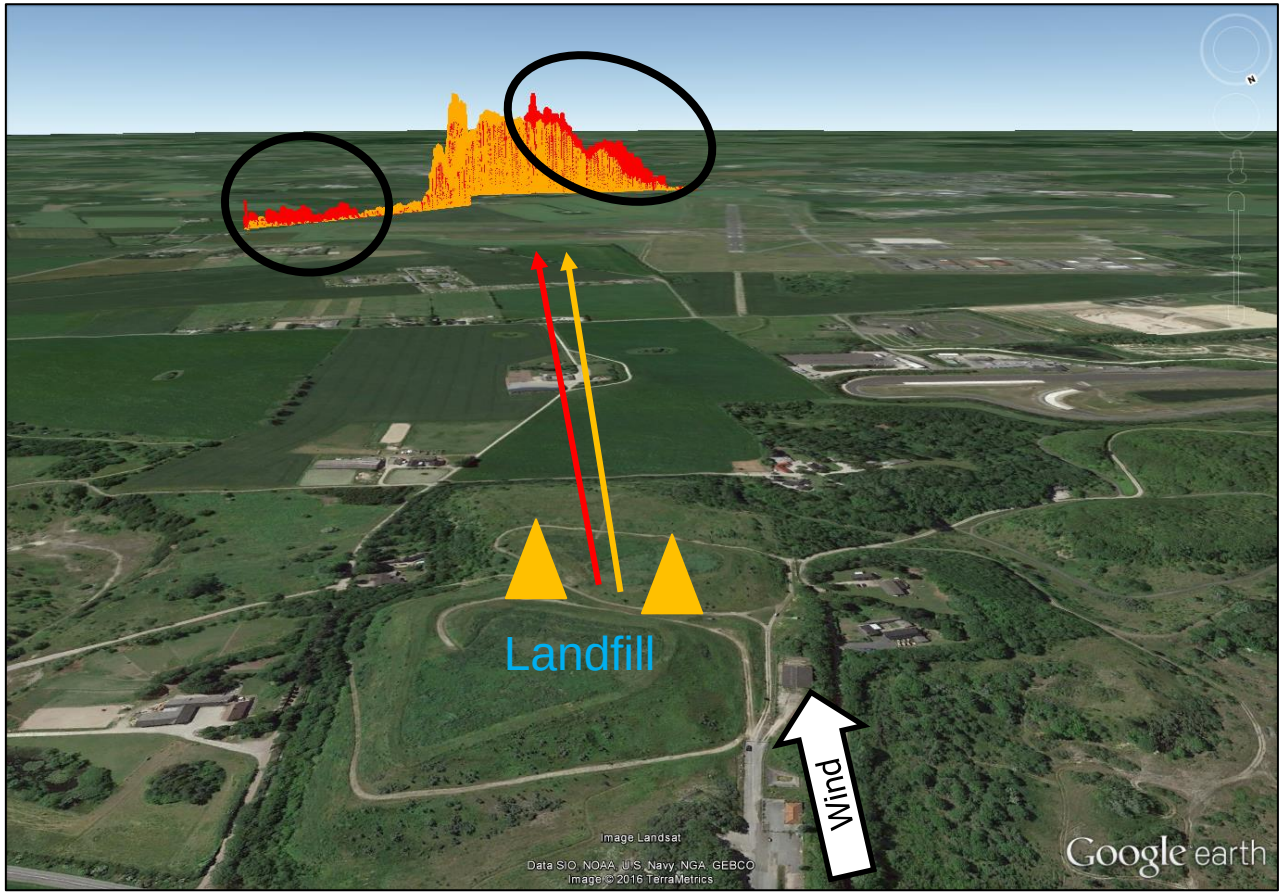
3) Measurements of the downwind plumes



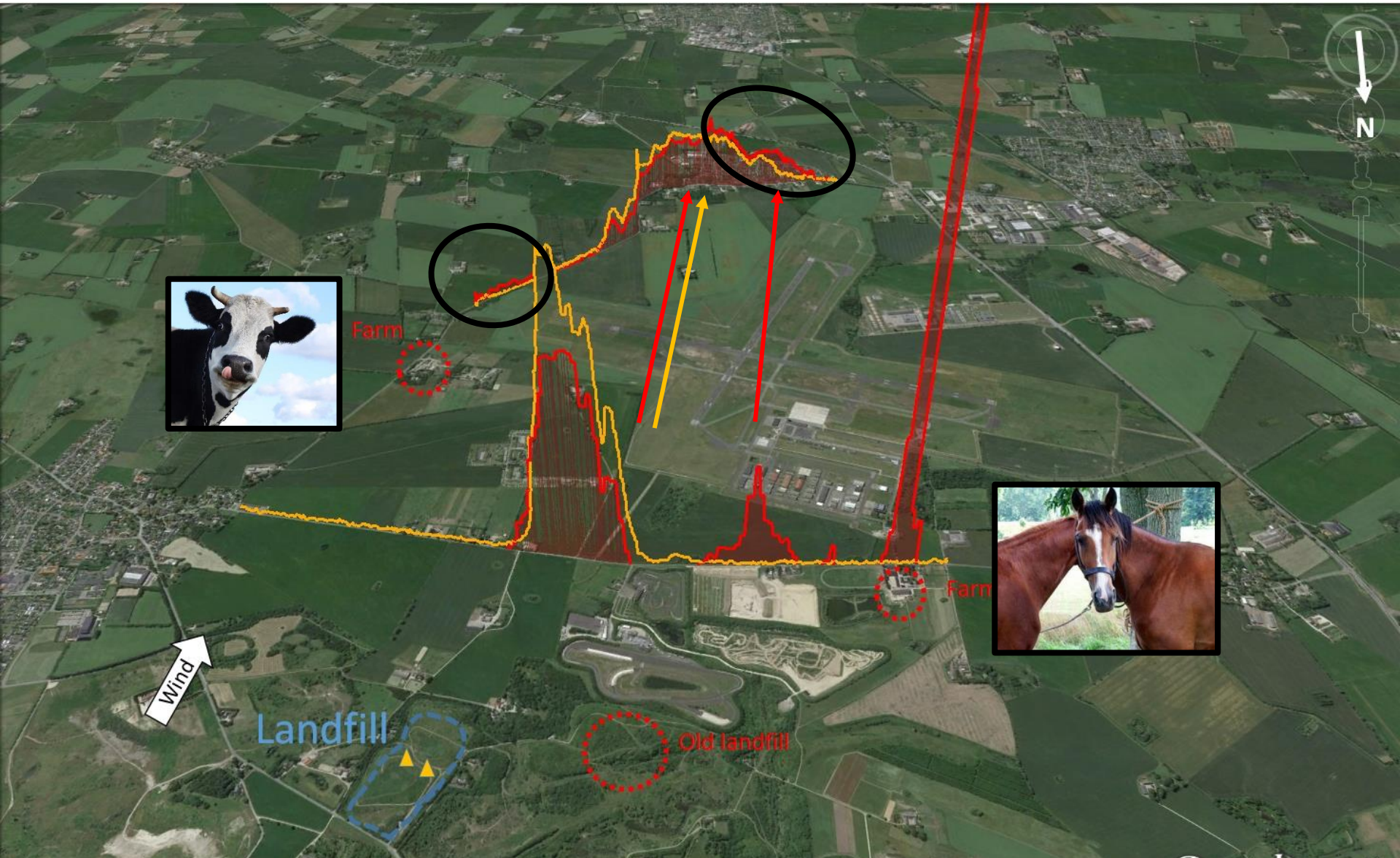
Time (hh:mm)	Methane mission (kg h^{-1})
12:32	10.2
12:44	10.7
12:53	10.6
12:56	12.8
13:01	11.0
13:03	13.6
13:06	10.7
13:09	11.7
13:13	12.9
13:19	11.9
13:21	11.5
13:23	11.7
13:26	11.2
13:32	12.7
13:34	13.9
13:36	13.6
13:38	12.8
13:43	10.6
13:46	11.7
Average	**11.9**
Std. Dev.	**1.1**
95% Conf. Int.	**0.6**

Dynamic tracer dispersion method Uncertainties

Interfering sources



Dynamic tracer dispersion method
Uncertainties



Dynamic tracer dispersion method Uncertainties

Measurement uncertainties:
Other sources*
Tracer gas release (flow & placement*)
Elevated sources*
Variation of background concentration*
Too low concentrations*
Sudden change in atmospheric conditions*

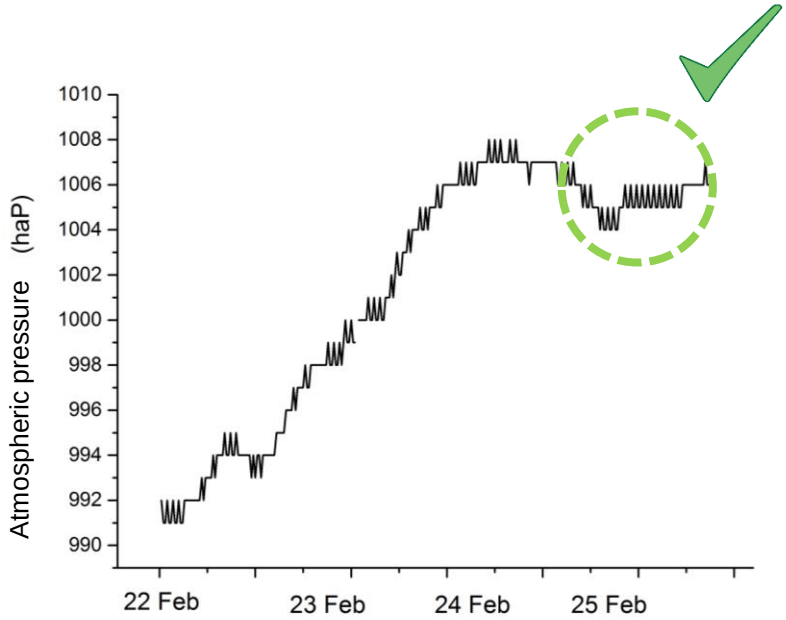
*) site specific




Landfill emission variation

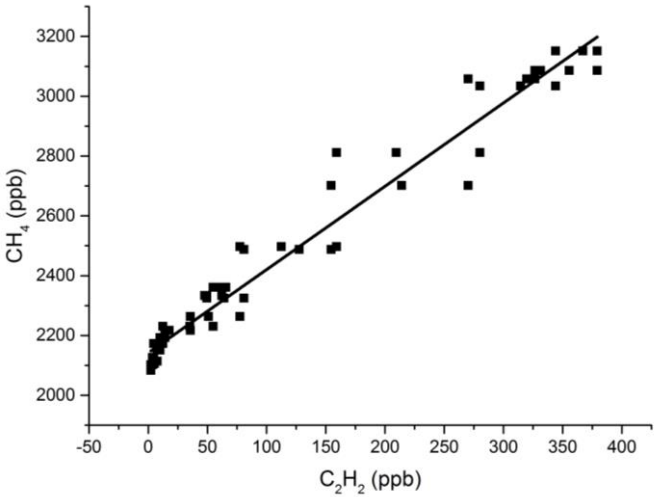
Atmospheric pressure (absolute & change)

- Wind
- Precipitation
- Temperature

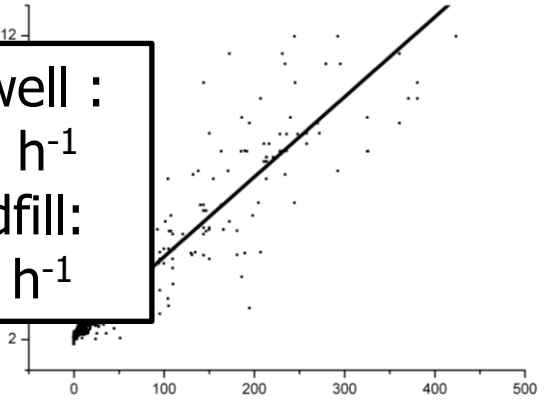


Dynamic tracer dispersion method Opportunities

Leachate well in the middle of a composting area: 0.6 kg CH_4 h^{-1}

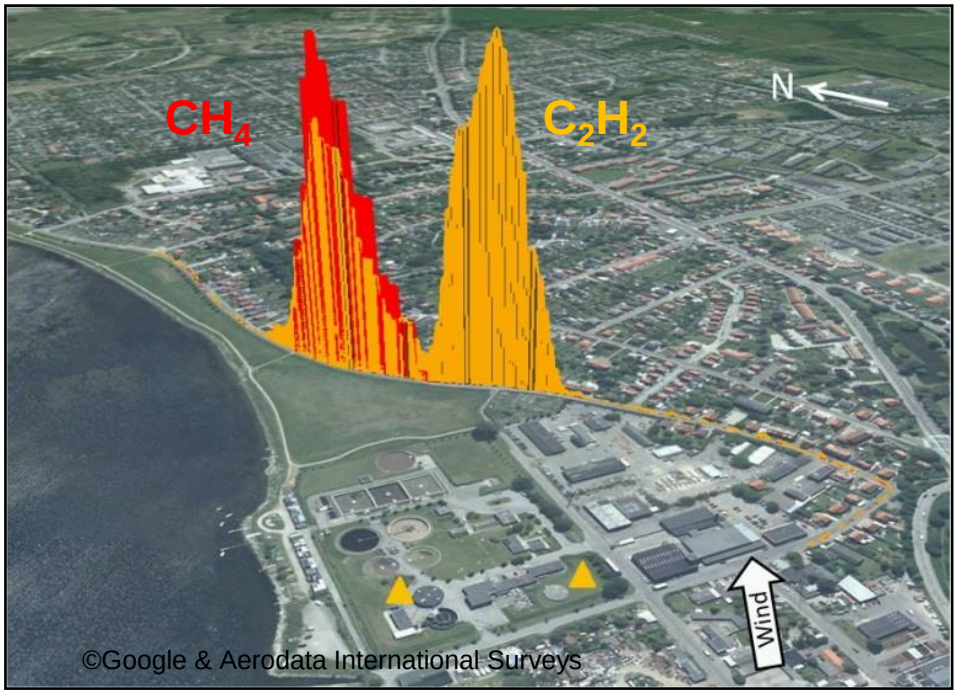


Leachate well : 5.3 kg CH_4 h^{-1}
Whole landfill: 6.9 kg CH_4 h^{-1}

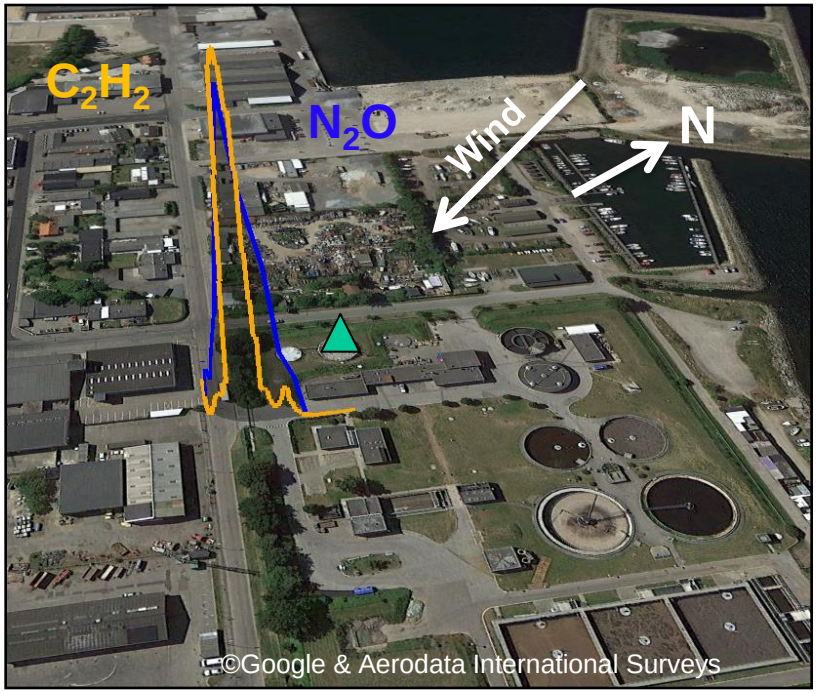


Dynamic tracer dispersion method Opportunities

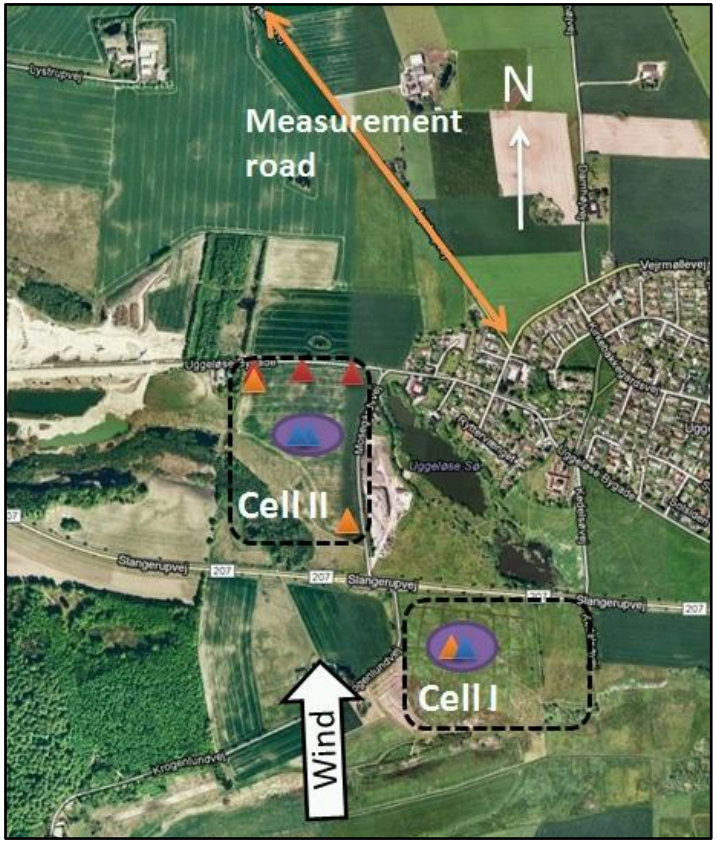
Whole site/area



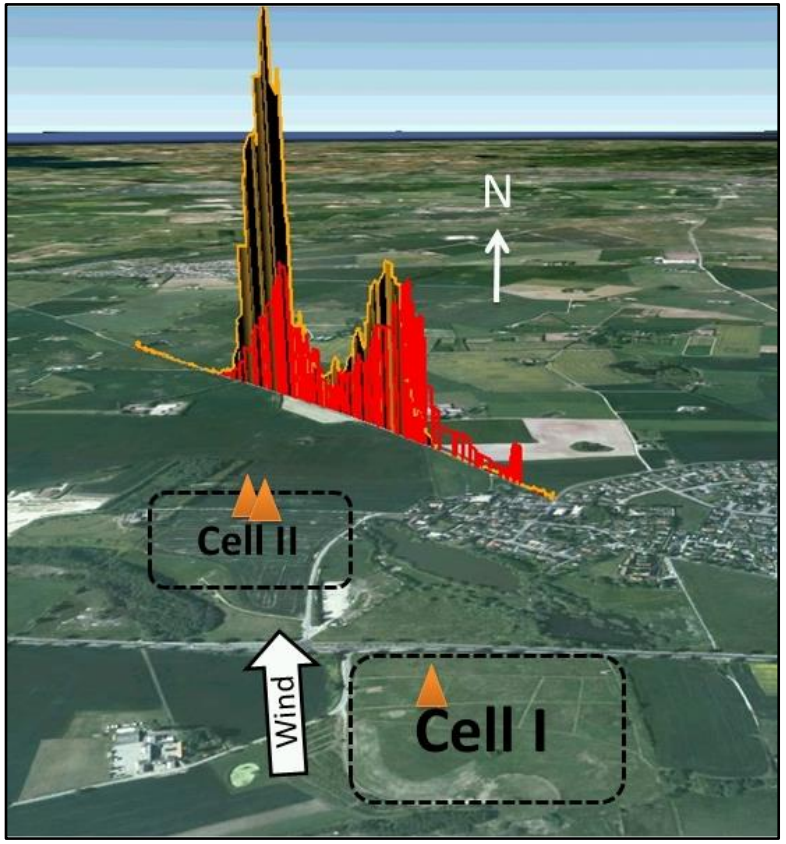
Single process



Dynamic tracer dispersion method Opportunities



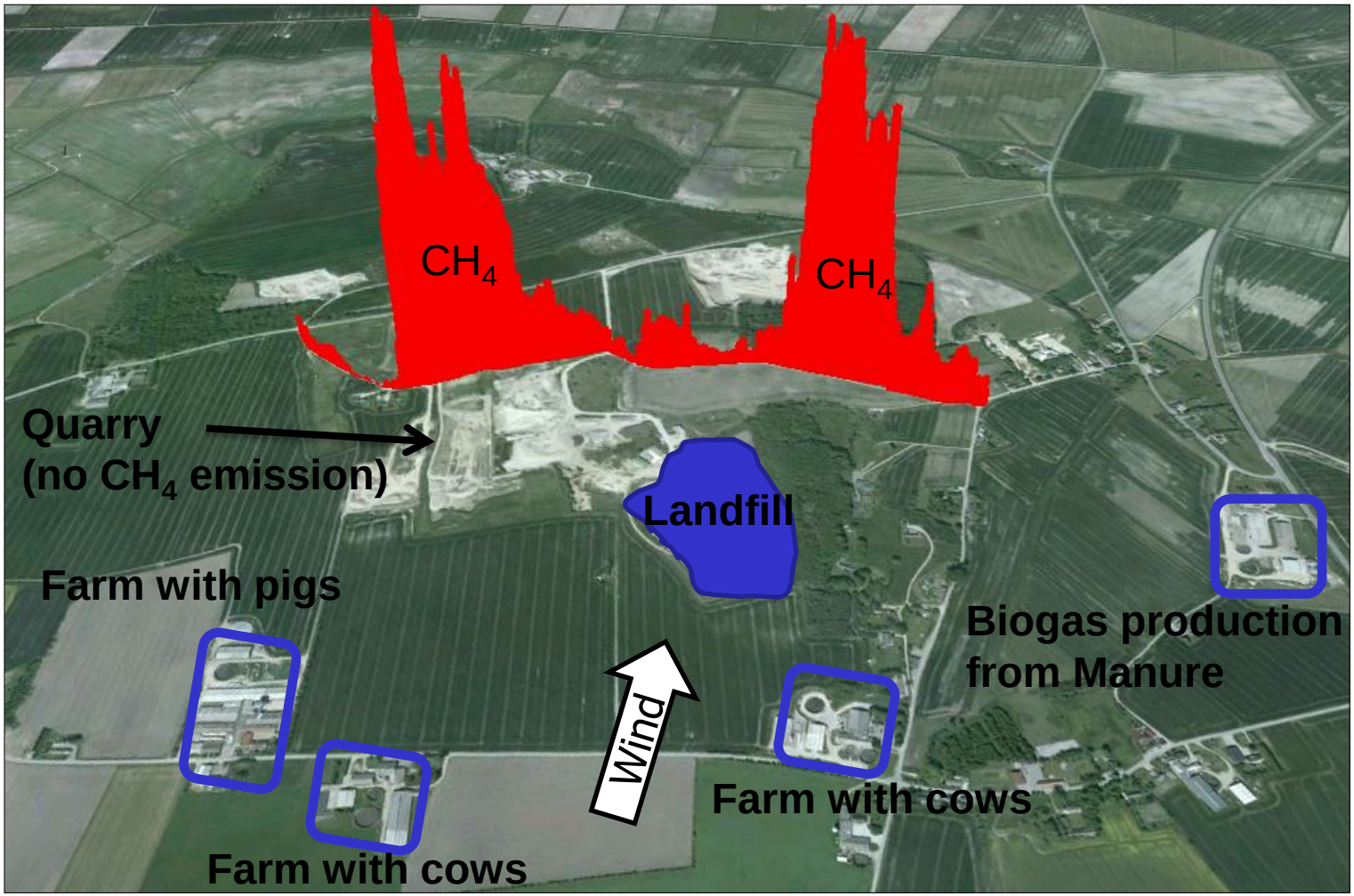
3 tracer gas configurations



Seperated plumes for quantification

Mønster et al. (2014)

Dynamic tracer dispersion method Challenges



Dynamic tracer dispersion method Results

Landfill	CH_4 emission measured (kg CH_4 h^{-1})	CH_4 emission measured (tons CH_4 y^{-1})	CH_4 emission reported (tons CH_4 y^{-1})
Audebo	16.0	140	664
AV Miljø	32.4	284	28
Eskelund	6.1	53	NR
Fakse	42.2	370	129
Feltengård	3.9	34	298
Frederiksværk	8.9	78	17
Glatved	60.8	533	3490
Hedeland	3.1	27	3390
Klintholm	15.0	131	1490
Odense	33.1	290	487
Skovsted	2.6	23	500
Skårup	11.9	104	24
Uggeløse	9.5	83	NR
Viborg	11.1	97	1260
Ærø	6.9	60	118
Average	17.6	154	793

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Mønster et al. (2015)

Dynamic tracer dispersion method Conclusion

+ Emission of methane (real time)
+ Locate and quantify emission hotspots
+ Quantify emission areas e.g. single landfill cell or biocover)

Measure down to 1 kg methane h^{-1}
Point source down to 10 g methane h^{-1}

Both depends on many factors

- Relative small time window
- Other sources
- Emission variation

Dynamic tracer dispersion method
Future work

Further validation of the method and instrumentation

+ Additional controlled release campaigns
+ Instrumentation intercomparison
+ Additional method intercomparison

Dynamic tracer dispersion method

Thank you for your attention

Further information: jmn@force.dk

References in presentation

Mønster, et al., 2014. Quantifying methane emission from fugitive sources by combining tracer release and downwind measurements - a sensitivity analysis based on multiple field surveys. Waste Management 34, 1416–1428.

Mønster, et al., 2015. Quantification of methane emissions from 15 Danish landfills using the mobile tracer dispersion method. Waste Management 35, 177–186.

Spørgsmål?

Artikler og anden dokumentation/information:

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